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STUDIES IN TROPICAL ASCOMYCETES—III

PORTO RICAN CUP-FUNGI

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(WITH PLATE 4)

During a recent trip in Porto Rico, January 24 to April 5, 1923, a number of species and genera of cup-fungi were collected, and others have been since sent in for determination, which are apparently undescribed, or at least new to the island. The present paper includes descriptions and notes on a number of such species and genera and is preliminary to a more thorough treatment of the fungi in the Botany of Porto Rico and the Virgin Islands in preparation by the New York Academy of Sciences.

While the fungi, especially the parasitic fungi, have been very thoroughly collected in Porto Rico, the cup-fungi have been overlooked and neglected. It is hoped that this preliminary list will help to arouse interest in the group and stimulate local collectors to search more diligently for these neglected forms. The collection of two species of Geoglossaceae, a family which so far as we know had not been previously reported from the island, would indicate that many more of such interesting forms may be represented there.

A. OPERCULATE SERIES

Cookeina tetraspora sp. nov.

Apothecia gregarious or becoming confluent and occasionally several fused together, the hymenium plane or slightly concave, pale orange, reaching a diameter of 3–5 mm., externally whitish, strongly wrinkled, clothed with delicate fasciculate hairs; asci

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clavate, reaching a length of 200 μ and a diameter of 12–14 μ, 4-spored; spores ellipsoid, unequal-sided, usually containing two oil drops, 10–11 x 24–27 μ (rarely a little larger), often showing faint striations; paraphyses filiform, slightly enlarged above.

On decaying leaves of some palm, El Yunque, also on rotten wood, same locality.

The type was collected December, 1912, by J. R. Johnston and listed by Stevenson in his checklist without description. A second collection was made by the writer on old sticks, February 25, 1923, in the same locality. The hairs in this species are not conspicuous and the spore striations are faint, their prominence probably depending on the maturity of the spores.

Humaria phyllogena sp. nov.

Apothecia sessile or subsessile, discoid or with the margin slightly elevated, reaching a diameter of 3–5 mm., flesh-red, brighter when dry; asci clavate, operculate, reaching a length of 200 μ and a diameter of 12 μ; spores broad-ellipsoid, 12 x 18–20 μ, usually containing two oil drops, smooth.

On dead leaves, El Yunque, Feb. 23–26, 1923.

This suggests the genus *Cookeina* but it differs in the absence of hairs and the nonstriated spores.

HUMARIA LEUCOLOMA (Hedw.) Quél. Ench. Fung. 289. 1886.

Octospora leucoloma Hedw. Descr. **2**: 13. 1788.

Two collections of plants referable to this species were made on mossy banks in the vicinity of Indiera Baja at an elevation of 800–900 M. The plants occurred in abundance and were quite characteristic except for slight variations in spore measurements.

Humaria Cookeina sp. nov.

Apothecia short stipitate or subsessile with the hymenium slightly concave, reaching a diameter of 2–3 mm., bright orange, a little paler outside, the stem slightly grooved or furrowed; asci clavate, 8-spored, 14–15 x 160 μ; spores partially 2-seriate, fusoid, 30 x 6 μ.

On decaying sticks, El Yunque, Feb. 25, 1924.

The species has the appearance of a *Cookeina* but seems to be devoid of hairs and the spores if striate are so faintly so as to leave the matter in doubt. A very scant collection was made and

further collections may give additional information on these points.

LAMPROSPORA DISCOIDEA (P. Henn. & E. Nym.) Seaver, Mycologia **6**: 19. 1914.

Barlaea discoidea P. Henn. & E. Nym. Monsunia **1**: 33. 1900.

One collection was made near Rio Piedras on the ground where cows had stepped. The plants were whitish and spores rather small, being 12–14 μ in diameter.

Lamprospora salmonicolor sp. nov.

Apothecia discoid with the hymeniun plane or slightly convex, reaching a diameter of 2 mm., pale salmon-colored; asci cylindric or subcylindric, reaching a length of 275 μ and a diameter of 20–24 μ; spores globose, filled with minute granules, 20 μ in diameter when mature; paraphyses clavate, reaching a diameter at their apices.

On bare ground, El Yunque, Feb. 23, 1923. Specimens abundant, differing from the preceding in the color and size of the spores.

? LAMPROSPORA WRIGHTII (Berk. & Curt.) Seaver, Mycologia **6**: 15, 1914.

Peziza Wrightii Berk. & Curt.; Berk. & Br. Ann. Mag. Nat. Hist. III. **15**: 444. 1865.

One specimen collected in the garden at the Experiment Station in Rio Piedras. The spores are subglobose.

LACHNEA COPRINARIA (Cooke) Phill. Brit. Discom. 224. 1887.

Peziza coprinaria Cooke, Grevillea **4**: 91. 1875.

Collected on dung in the vicinity of Indiera Baja. Common but apparently not previously known from Porto Rico.

PEZIZA ADNATA Berk. & Curt.; Berk. Jour. Linn. Soc. **10**: 365. 1868.

Several specimens were collected on rotten wood which seem to conform with the description of this species. The hymenium was chocolate brown and the apothecia partially adherent to the substratum but with the margin free.

Phillipsia Chardoniana sp. nov. (PLATE 4.)

Apothecia orbicular or nearly so, subsessile, reaching a diameter of 2–3 cm., eccentrically attached, the hymenium bright reddish, the substance thin (about 1–2 mm., not thick or corky as in other species); asci cylindric or subcylindric, reaching a length of 300 μ and a diameter of 14 μ, 8-spored; spores ellipsoid, unequal-sided, usually containing two large oil drops, longitudinally striated with light and dark bands, about 26 x 12 μ.

On decaying wood, Ajuntas, December 24, 1923, *C. E. Chardon 304*.

This was at first thought to be *Peziza dochmia* Berk. & Curt., which is a *Phillipsia* as the genus is now understood. Our plant differs, however, in its larger size, more orbicular form and especially in the much brighter color of the apothecia. Since it seems to be sufficiently different, we describe it and dedicate it to Carlos E. Chardon who collected the plant and has furnished the color illustration, drawn by Mario Brau of the Museum of the Department of Agriculture of Porto Rico.

PYRONEMA OMPHALODES (Bull.) Fuckel, Symb. Myc. 319. 1869.

Peziza omphalodes Bull. Herb. Fr. *pl. 485. f.* 1. 1790. Hist. Champ. 264. 1809.

On soil in a charcoal pit, near Barros Road. Although apparently common everywhere, so far as the writer is aware this is the first time the species has been collected in Porto Rico.

B. INOPERCULATE SERIES

BELONIDIUM LEUCORRHODINUM (Mont.) Sacc. Syll. Fung. **8**: 501. 1899.

Peziza leucorrhodinum Mont. Hist. de Cuba, Pl. Cell. 360. 1842.

On the mycelium of Perisporiaceae on various hosts. This little *Orbilia*-like discomycete has been frequently collected in Porto Rico.

Ciboria caespitosa sp. nov.

Apothecia gregarious and usually in cespitose clusters, with a short stout stem-like base, with the hymenium concave, irregular in form and reaching a diameter of 1 cm., externally chestnut brown and densely furfuraceous, the minute wart-like roughenings consisting of rudimentary hair-like structures, the hymenium

darker, almost black; asci clavate, strongly enlarged upwards, 120 x 10 μ; spores ellipsoid, hyaline, 18–20 x 5 μ, often with the ends attenuated.

On some wood (*Inga laurina* (Sw.) Willd.?), El Yunque, Feb. 24, 1923.

The fungus occurred in abundance and on account of its size is a conspicuous and attractive species.

? DASYSCYPHA FLAVIDULA Rehm, Ann. Myc. **7**: 542. 1909.

Specimens collected on dead stems (fern ?) conform rather closely with the above so far as we can judge from the description. No authentic specimens have been seen.

? ERINELLA SIMILIS Bres. Hedwigia **36**: 296. 1896.

Several collections of what appears to be this species have been made by the writer in Porto Rico. As stated by Bresadola the species resembles in general appearance *Dasyscypha calycina*. The spores in our specimens are fusiform, reaching a length of 35–40 μ and a diameter of 2–3 μ.

GEOGLOSSUM NIGRITUM Cooke, Mycographia 205, *pl. 96. f. 345.* 1878.

One single plant of this species was collected by Mrs. E. G. Britton in the valley of the Toro Negro, at an altitude of 550–600 meters.

GEOGLOSSUM PUMILUM Winter, Grevillea **15**: 91. 1886.

This dwarf species was based on material collected in Brazil. In December of 1912 two or three tiny plants were collected in Bermuda, which were referred doubtfully to this species. In January, 1923, two more minute plants of what appears to be the same species were collected in a ravine near the experiment station. Except for a slight variation in the size of the plants and spores, the specimens from Bermuda and Porto Rico agree well and both conform with the description of the above. The spores are 15-septate and from 100–140 x 4–5 μ. The species occurs on bare ground in shaded places.

Hysterographium Pithecellobii sp. nov.

Apothecia gregarious or crowded into little groups, straight or slightly curved, prominent, the lips tightly compressed, reaching

a length of 1 mm., smooth or faintly striated; asci clavate, reaching a length of 100 μ, 8-spored; spores ellipsoid or with the ends slightly attenuated, usually 3-septate, and slightly constricted at the middle septum, with one longitudinal septum extending through the two central cells, pale to dark brown, 20 x 8 μ.

On twigs of *Pithecellobium Unguis-cati* (L.) Mart.

Ionomidotis portoricensis sp. nov.

Apothecia cespitose, sessile or subsessile, reaching a diameter of 5–8 mm., irregular in outline from crowding, externally light brown, minutely furfuraceous and wrinkled when dry, the hymenium darker, almost black; asci clavate, 30 x 5 μ, 8-spored; spores ellipsoid, 2 x 4–6 μ; paraphyses slightly enlarged upwards.

On dead wood, Porto Rico.

Phialea Cecropiae (P. Henn.) comb. nov.

Helotium Cecropiae P. Henn. Hedwigia **41**: 25. 1902.

Plants referable to this species originally described from southern Brasil were abundant on the fallen leaf sheaths of *Cecropia*. Several collections were made.

Phialea microspora sp. nov.

Apothecia gregarious, stipitate or subsessile, not exceeding 1 mm. in diameter, the hymenium slightly concave and dull yellow, externally a little darker and clothed with clusters of cells, which approach rudimentary hairs, scarcely reaching a diameter of 1 μ; asci clavate, about 30 x 4 μ, 8-spored; spores very small, about 6 x 1.5–2 μ.

On the upper side of leaves of unidentified host, Rio Piedras, Feb. 28, 1923; also on herbaceous stems. Apparently closely related to *Helotium phlebophorum* Pat.

NEW YORK BOTANICAL GARDEN.

MODES OF INFECTION OF SORGHUMS BY LOOSE KERNEL SMUT[1]

JAMES A. FARIS AND GEORGE M. REED

(WITH PLATES 5–7)

MODES OF INFECTION IN CEREAL SMUTS

The various species of cereal smuts differ in certain essential points in the mode of entrance into their respective hosts. The most common method seems to be the penetration of the young seedling by means of germ tubes arising from conidia, which, in turn, originate from the chlamydospores present on the seed or in the soil. Following penetration the fungus develops its mycelium in the embryonic tissue of the host. As the latter reaches its later stages of development the growth of the mycelium becomes particularly vigorous and forms a large mass of chlamydospores. We thus have a systemic development of the mycelium of the fungus in the host. This type of seedling infection occurs in several of the cereal smuts: *Tilletia laevis* Kühn, *T. Tritici* (Bjerk.) Wint., and *Urocystis Tritici* Kcke. on wheat; *Urocystis occulta* (Wallr.) Rab. on rye; *Ustilago Avenae* (Pers.) Jens. and *U. levis* (K. & S.) Magn. on oats; *Ustilago Hordei* (Pers.) K. & S. on barley; *Sphacelotheca cruenta* (Kühn) Potter, *S. Sorghi* (Link) Clint., and *Sorosporium Reilianum* (Kühn) McAlpine on sorghum. In some cases the spores are formed in the stems and later leaves. Wheat plants infected by *Urocystis Tritici* are very greatly stunted and commonly are prevented from heading, or if an infected plant does head, very little seed is produced. The fungus attains its greatest development in the leaves and to some extent in the stems. Long blackish lines appear between the veins of the leaves, due to the formation of the spores in linear masses. These later rupture and the spores escape. The effects of *Urocystis occulta* on rye are somewhat similar. The infected plants, however, more fre-

[1] Brooklyn Botanic Garden Contributions No. 44.

quently head out, although usually no grain is produced. The spores are formed in linear sori on the leaves and stem. The formation of sori on leaves also may occur in other smuts, as in *Ustilago Avenae* and *U. levis* on oats and *U. Hordei* on barley. However, in most of the other cereal smuts just mentioned the formation of spores takes place principally in the ovaries, although the adjacent tissues of the enclosing glumes may also be invaded. In the head smut of sorghum the entire panicle is commonly involved.

The second method of penetration is by means of germ tubes which arise directly from the chlamydospores and infect the young ovaries of the flowers. The loose smuts of wheat (*Ustilago Tritici* (Pers.) Jens.) and of barley (*U. nuda* (Jens.) K. & S.) illustrate this type of penetration, known as "flower" or "blossom" infection. In the matured seed there is present the dormant mycelium which renews its growth when the seed germinates. The mycelium occurs throughout the embryonic tissue of the developing host. When the latter begins to form its flowers, the fungus develops very rapidly and in place of the normal seed and adjacent tissues the smut spores are formed. In this case also we have a general systemic infection. The penetration of the host, however, occurs at the blossoming period by means of spores which are carried to the stigmas.

A third method, known as "local infection," occurs in the common corn smut (*Ustilago Zeae* (Beckm.) Ung.) in which any embryonic tissue of the roots, stems, leaves or flowers may be penetrated by the germ tubes which arise from conidia, produced by the germination of the chlamydospores. The fungus requires only a short time to complete its development, forming localized mycelium which, in two to three weeks, produces ripe spores. The cycle of development may be repeated several times during the growing season of the crop.

A fourth method known as "shoot infection" has been described by Hecke (**5**). Hecke cut back in the autumn to the ground level the shoots of the perennial *Secale montanum* and heavily inoculated the crown of the plants with the spores of *Urocystis occulta* (Wallr.) Rab. and then covered with manure containing spores. In the following year new shoots of the host

developed and these were found to be infected by the smut in the characteristic manner. Similar experiments were carried out on two-year-old plants of *Lychnis alba*. The plants were cut back to the ground level and the surfaces dusted with the spores of *Ustilago violacea* (Pers.) Fckl. and covered with manure mixed with spores. In a few days new shoots developed which flowered in the following year. These flowers were smutted in the characteristic fashion, the anthers containing the mature smut spores.

Zade (**10**) has suggested a new method of infection of oats by *Ustilago Avenae*. He found that the spores germinated readily on the stigmas of the flowers, giving rise to budding sporidia; the latter gave rise in turn to hyphae which came in contact with the inner wall of the glumes and there formed a mycelium. Zade concluded that this mycelium and the secondary sporidia which are borne on the hyphae on the inner surface of the glumes constitute the most important source of infection in oat smut. The fact, however, that high percentages of infection of hulled oats may be obtained by dusting the seed with spores indicates that seed inoculation is very effective in the production of oat smut.

EVIDENCE OF SEEDLING INFECTION OF SORGHUM BY *Sphacelotheca cruenta*

Hitherto the evidence has been that the mode of infection in the loose kernel smut of sorghum, *Sphacelotheca cruenta*, is a typical seedling penetration. Brefeld (**1**, **2**) successfully produced infection by inoculating sorghum seed with the spores of this smut. He obtained as high as 72 per cent infection when he inoculated the germinated seed at the time that the growing point was just emerging from the seed coat. The percentages of infection greatly decreased if the plumules were 1 to 2 cm. long at the time of inoculation, and, further, if the first leaf had pushed through the sheath as much as 1 cm. no infection was obtained. Brefeld also tried to infect sorghum plants 5 in. to 2 ft. in height by pouring cultures of conidia into the cornucopia formed by the leaves, a method which proved very successful in the case of corn smut. He observed that the very young leaves of the sorghum shriveled, became quite pale and gave every evidence of the

development of mycelium in their tissues. Later, however, normal leaves appeared and the plants finally attained their usual appearance. No smut spores developed in the ovaries or any other part of the plant.

Brefeld and Falck (**4**), following their studies on the life history of the loose smuts of wheat and barley, raised the question as to whether flower infection might not occur in the case of *Sphacelotheca cruenta*. They inoculated flowers of sorghum at the blooming period but did not succeed in determining whether blossom infection took place, since they were unable to get the sorghums to develop to maturity in their locality and produce ripe grain. Brefeld (**3**), in a later paper, again suggested the possibility but was unable to demonstrate it.

Potter (**7**) obtained the infection of a few varieties of sorghum by inoculating the seed with the chlamydospores of *Sphaceiotheca cruenta*. He further found that the formaldehyde method of seed treatment was effective in preventing loose kernel smut. Kulkarni (**6**) also succeeded in producing the infection of sorghums by loose kernel smut by inoculating the seed with spores. He also demonstrated the effectiveness of seed treatment when inoculated seed was treated with a two per cent solution of copper sulphate for ten minutes. Reed (**8**) has inoculated the seed of a large number of varieties of sorghum with the dry spores of loose kernel smut and has obtained infection in a very large number. The percentages of infection varied greatly, depending upon the variety. The highest percentage was obtained with Darso, 65 per cent of the plants being infected. Reed and Faris (**9**) also were successful in securing the infection of certain varieties of sorghums by the method of inoculating the dry seed with the dry spores.

All this evidence points to the fact that the successful penetration of *Sphacelotheca cruenta* into susceptible varieties of sorghums takes place in young seedlings by means of hyphae which originate from conidia, which in turn develop from chlamydospores present on the seed. It is possible that infection may also take place from spores found in the soil, but at present there is no evidence that this commonly occurs in this smut.

Reed (**8**) has summarized the striking pathological effects of

Sphacelotheca cruenta on its hosts. One of the most obvious features was observed in connection with the date of emergence of heads on infected and on normal plants. As a rule the infected plants headed out very much earlier than the normal. In fact, practically all of the heads of the smutted plants had fully emerged before any normal heads had appeared. Associated with this early emergence there were marked differences in the height of the infected plants as compared with the normal. The first to head out were only a few inches high. They usually had only two or three internodes, as compared with ten or twelve on the normal plant. The later ones to head, however, were practically as tall as the normal. However, the average for the normal and infected plants for nearly all varieties showed a marked decrease in the height of the infected. A still further point was observed in connection with the extent of tillering. An excessive number of tillers usually arose at the ground level and there was frequently an extensive development of side branches on the main stem. Consequently, young smutted heads continued to appear from lateral branches during the growing season. This extensive tillering and branching was more marked in the plants that headed out early as compared with those that headed out late.

A NEW MODE OF INFECTION OF SORGHUM BY *Sphacelotheca cruenta*

Sphacelotheca cruenta was first grown at the Brooklyn Botanic Garden in 1922 in a series of experiments designed to determine the resistance of sorghum varieties to this smut. These results are described elsewhere (**8**). The first experiments were started on May 23d, when the seed of several varieties of sorghums was inoculated with the spores and sown in the field. Many of these varieties proved to be susceptible and a considerable number of smutted plants with the characteristic symptoms were produced. The sori on these infected heads soon broke open and permitted the wide distribution of the spores in the field.

Field Observations.—Late in the season of 1922 some unusual cases of infection were noted on sorghum plants that had not previously been inoculated with the spores of loose kernel smut.

Individual plants which developed in the normal fashion and produced sound terminal heads late in the season produced lateral heads which were infected by the loose kernel smut. In none of these cases was there any dwarfing or excessive tillering of the plants. They thus differed from those that were infected by seed inoculation. These peculiar cases were especially observed in Valley Kaoliang, which was growing several rods away from the plot where the seed inoculated with *Sphacelotheca cruenta* was sown. This variety produced a number of branches from the upper nodes, perhaps due in part at least to the destruction of the grain by birds. The lateral heads infected with loose smut arose from the various nodes on the plant (Plate 5). Usually these terminal heads on the lateral branches were completely smutted but in a few cases partially smutted panicles were observed. In one case the terminal head of a plant, the seed of which had been inoculated with spores of *S. Sorghi*, was infected with the covered smut but from the third node from the top a branch originated which produced a head some of whose flowers were normal, some infected with *S. Sorghi* and others with *S. cruenta*.

It might be thought that the appearance of these lateral infected heads on plants with normal terminal ones was due to the fact that the smut, which had penetrated the seedlings, had failed to reach the terminal head but succeeded in attaining the growing point of the lateral heads. It has frequently been observed in the other smuts of cereals, oats for example, that a plant may produce normal heads followed later by smutted ones. The fact, however, that several of these infected sorghum plants appeared in the rows where the seed had not been inoculated by *Sphacelotheca cruenta* precluded this explanation. Further, the main series of experiments with sorghums in 1922, in which spores of *S. Sorghi* were used, was started in April. Several hundred seeds of different varieties were inoculated with the covered smut and germinated under controlled conditions in the constant temperature tanks in the greenhouse. They were then potted and kept in the greenhouse until May 12th to 21st when they were transplanted to the field. At the time of transplanting they ranged from approximately 6 inches to 2 feet in height. The plants in this series of experiments had no opportunity to

become inoculated by *S. cruenta* before they were transplanted to the field, since no spores of this fungus had ever been used in previous experiments at the Botanic Garden and there was no chance for the seed to become inoculated in threshing. Furthermore, the loose kernel smut was not used in or about the laboratory until May 23, several weeks after these experiments had been begun. It may also be well to emphasize the fact that no cases of typical systemic infection of *S. cruenta* occurred anywhere in the plot except where the seed had been inoculated with the spores of this smut.

Consequently, the occurrence of these infections of lateral heads led to the supposition that some other mode of inoculation and infection than through the seedlings might occur. The plausible explanation seemed to be that the loose kernel smut spores were carried to the lateral bud of developing panicles, or the young flowers, where infection took place at once, giving rise in a few weeks to the smutted kernels. As further evidence on this point it may be pointed out that relatively large numbers of loose kernel smut spores were being distributed throughout the field, beginning in the latter part of July, about the time that normal heads of sorghums were beginning to appear in some of the early plantings. As the season progressed the number of spores being thus distributed was greatly increased. It was further found that, in general, the number of plants with normal terminal heads and lateral heads infected with loose kernel smut was greatest in the vicinity of the rows which were showing relatively high percentages of loose smut.

In 1923 extensive series of plantings of sorghums, separate lots of seed being inoculated with *Sphacelotheca Sorghi* and *S. cruenta*, were made in order to determine the temperature and moisture relations of infection. These results have been reported elsewhere (**9**). During this season also there were observed a number of cases where plants which grew normally and produced sound terminal heads later produced lateral heads with the usual symptoms of loose kernel smut. Careful records of these were made with special reference to their location in the plots. The number of these increased greatly as the season advanced. In other words, as the normal plants produced a larger number of

lateral branches, the number of infected ones increased and no final data regarding the total number were recorded. Such infections occurred on plants which had been inoculated with *S. Sorghi* as well as with *S. cruenta*. It may be emphasized, however, that no cases of characteristic systemic infection of *S. cruenta* occurred in any row except where the seed had been inoculated with the loose kernel smut. There was no evidence of any chance contamination of seed by this smut.

Only a few varieties of sorghum were grown in 1923 and the appearance of the infected laterals was again especially noted in Valley Kaoliang. However, other cases of special interest also were observed. On some terminal heads of Darso, Blackhull Kafir and Valley Kaoliang a few individual kernels were found to be infected. As a rule all the flowers of the panicles are destroyed by the loose kernel smut. In the cases just mentioned, however, a small number of flowers were attacked and the appearance of the smut balls differed somewhat from the usual type, the special peculiarities of which are described below.

The facts observed gave strong support to the idea that a hitherto unknown mode of infection of sorghums by loose kernel smut might occur. In order to determine whether this was the case, a number of plants of Valley Kaoliang, which showed infected lateral heads, were dug up late in the fall of 1923 and over-wintered in the greenhouse. Careful records were made on the distribution of the lateral smutted heads on these plants. In the spring of 1923 they were set out in the field and grown to maturity. The accompanying table gives a record of the 19 plants which were carried through in this manner.

During the season of 1924 all of these plants produced from three to six or more stalks of equal height and vigor. In addition, particularly early in the season, a number of short stalks were also produced. Seventeen of these plants proved to be entirely sound. No smutted panicles were observed on either the short stalks or the long. Two plants, however, Nos. 6 and 7, gave rise to a few short stalks, the heads of some of which were infected in the characteristic manner by *Sphacelotheca cruenta*. Both of these plants, however, also gave rise to strong vigorous stems, upon which sound panicles developed.

One plant of Darso which showed a few infected kernels on the terminal head also was carried through in the same fashion. This plant produced several heads in 1924 without the slightest evidence of any infection by *Sphacelotheca cruenta*.

DISTRIBUTION OF SMUTTED LATERAL PANICLES ON VALLEY KAOLIANG—1923

Plant numbers	Number of node from top of plant				
	2d	3d	4th	5th	6th
1[a], 3, 4, 12[a]	S	—	—	—	—
2[b], 6, 9, 10, 15	N	S	—	—	—
5[c], 11[a]	S	N	—	—	—
13[a], 14[a]	—	S	—	—	—
7	S	S	—	—	—
8	N	S	N	S	—
16, 17	N	N	—	S	—
18	—	N	—	—	S
19[d]	—	—	—	—	—

S indicates that the lateral branch bore a smutted panicle and N indicates that it bore a normal panicle.

The dash (—) indicates that no lateral branch developed from this node.

[a] The lateral branch produced secondary smutted heads in addition to the terminal one.

[b] A branch with normal head also arose from the first node.

[c] The head was only partially smutted.

[d] A few flowers near the base of the terminal head were infected. Plants 6 and 7 showed smutted branches in 1924.

These facts in general fit with the interpretation that infection occurred in the young panicle buds or in individual flowers by means of spores which were carried by the wind or other possible agents from adjacent infected plants. Apparently if the spores reached the young developing panicle in sufficient numbers and at the right stage of development, all the flowers were infected. If, however, the stage of development of the flowers was not favorable or the spores were not sufficiently numerous, only a few flowers became infected. In every case, however, the infection was localized. The mycelium apparently did not grow backwards into the stem and later attain the embryonic tissues of other panicles. It is probable that the panicles on the two plants which showed infection in 1924 had become inoculated during the period of their embryonic development and that a characteristic local infection occurred.

Greenhouse Inoculation Experiments.—In order to definitely determine whether a secondary local infection of the panicles or individual flowers, as distinct from a general systemic infection through seedlings, can be produced in sorghums by *Sphacelotheca cruenta*, a series of experiments was carried out under controlled conditions. Five varieties of sorghum were planted in pots in the greenhouse April 19, 1924. The seed used was smut free and the plants had no opportunity to become accidentally inoculated. On August 27 some of the plants had produced terminal heads, all of which were sound. These terminal heads were removed and inoculations were made by injecting spores of *S. cruenta* into either the boot, into the growing point, or between the leaf sheath and internode, as indicated in the following description of the various plants. The spore material used was secured from newly smutted heads in the field just as they began to appear. The smut balls were broken up and dusted into a beaker of tap water. The spore suspension thus obtained was injected into the sorghum plants with a hypodermic needle. The details for each plant are recorded below:

VALLEY KAOLIANG (S.N. 192). Ten plants.

Plant No. 1. Terminal head sound, removed, and the first lateral branch injected at the base of the cornucopia. Marked lesions upon the new unfolding leaves appeared within a few days.

Results: Oct. 1. First and second panicles on lateral branch completely smutted.

Oct. 14. Two uninoculated tillers remained sound.

Plant No. 2. Terminal head inoculated by injecting the growing point at base of cornucopia with a suspension of spores just before the head began to swell.

Result: Oct. 14. Head partially smutted (Pl. 6, Fig. 1). Two uninoculated lateral branches remained sound.

Plant No. 4. Terminal head sound and removed when a lateral branch was inoculated at top of cornucopia.

Result: Oct. 7. No infection.

Plant No. 5. Terminal head sound and removed when a lateral branch was inoculated at base of the cornucopia.

Result: Oct. 7. No infection.

Plant No. 7. Terminal head sound and removed when two lateral branches (*a*) and (*b*) and the first and second tillers were inoculated near the growing points.

Results: Sept. 29. A lateral panicle on branch (*a*) completely smutted, and some kernels on the terminal panicle of branch (*b*) smutted.

Oct. 7. The terminal head on branch (*a*) completely smutted.

Oct. 14. The two tillers headed. No infection.

Plant No. 8. Terminal head sound and removed when a lateral branch was inoculated at growing point.

Results: Sept. 29. Head of the lateral branch completely smutted.

Oct. 1. Two lateral heads on the lateral branch also completely smutted.

Plant No. 10. Terminal panicle sound and removed when two lateral branches (*a*) and (*b*) were inoculated at the growing point.

Results: Sept. 20. Terminal panicle on branch (*a*) smutted.

Oct. 7. No infection of panicle on branch (*b*).

Oct. 14. A lateral panicle on branch (*a*) completely smutted.

Plants No. 3, 6 and 9. Checks. October 14. No infection in any.

BLACKHULL KAFIR (S.N. 223). Six plants.

Plant No. 1. "Boot" filled with inoculum just as the apex of the head was about to emerge.

Result: Oct. 14. Head partially smutted. Two lateral branches not inoculated—no infection.

Plant No. 2. "Boot" filled with inoculum when the head was about one half the length of the top leaf sheath.

Result: Oct. 14. Head partially smutted (Pl. 6, Fig. 2). Two lateral branches not inoculated—no infection.

Plant No. 4. "Boot" filled with inoculum when the head development was between the stages of plants No. 1 and No. 2.

Results: Sept. 20. Many kernels of terminal head smutted.

Oct. 14. Lateral branch not inoculated—no infection.

Plant No. 5. "Boot" filled with inoculum when the head was about the stage of development of plant No. 2.

Result: Sept. 25. Lower part of head blighted. Some kernels smutted.

Plants No. 3 and 6. Checks. Oct. 14. No infection.

DARSO (S.N. 225). Six plants.

Plant No. 1. "Boot" filled with inoculum just as the head was beginning to enlarge.

Results: Sept. 20. Many smutted kernels (Pl. 6, Fig. 3).

Oct. 14. Two lateral branches not inoculated. No infection.

Plant No. 2. "Boot" filled with inoculum just as the head began to break through the last leaf sheath.

Results: Sept. 20. Partially smutted head.

Oct. 14. One lateral branch not inoculated—no infection.

Plant No. 4. "Boot" filled with inoculum just as head began to emerge. Two lateral branches injected at the base of cornucopia.

Results: Sept. 20. Terminal head partially smutted.

Oct. 14. Panicles on both lateral branches smutted. A third lateral branch and one tiller not inoculated—no infection.

Plant No. 5. "Boot" filled with inoculum just as the head began to emerge. One tiller injected at the growing point.

Results: Sept. 20. Head partially smutted.

Oct. 7. Tiller totally smutted.

Plants No. 3 and 6. Checks. Oct. 14. No infection.

RED AMBER SORGO (S.N. 232). Six plants.

Plant No. 1. Inoculated just as head was about to emerge from the "boot." Two tillers injected at base of cornucopia.

Results: Sept. 20. Terminal head partially smutted.

Oct. 14. Both tillers sound.

Plant No. 2. Terminal head inoculated at about the same stage of development as the terminal head of plant No. 1.

Result: Sept. 20. Partially smutted.

Plant No. 4. Terminal head sound and removed when two lateral branches (*a*) and (*b*) were injected at the base of the cornucopia.

Results: Sept. 22. Terminal panicle on branch (*a*) partially smutted.

Oct. 1. Much distortion and lateral branch (*b*) killed. A secondary branch on branch (*b*) smutted.

Oct. 14. A second lateral panicle on branch (*a*) completely smutted.

Plant No. 5. Terminal head injected at base of the cornucopia.

Results: Sept. 12. Head blasted and failed to develop. Three lateral branches inoculated by putting spores under leaf sheath.

Sept. 29. Two lateral branches completely smutted. The third blasted and did not develop.

Plants No. 3 and 6. Checks. Oct. 14. No infection.

SORGHUM FROM INDIA (S.N. 263). Four plants.

Plant No. 1. Terminal head injected at the base of the cornucopia.

Result: Oct. 14. No infection.

Plant No. 2. Terminal head injected at the base of the cornucopia.

Result: Oct. 14. No infection.

Plant No. 3. Check. Oct. 14. No infection.

Plant No. 4. Terminal head injected at the base of the cornucopia.

Result: Oct. 14. Kernels of the lower two thirds of the head were smutted and had the appearance of kernels of plants infected in the seedling stages. A head on a lateral branch completely smutted.

Of the ten plants of Valley Kaoliang six attempts at artificial inoculation resulted in infection, while four failed to develop smut. All trials with Blackhull Kafir and Darso were successful, while six inoculated heads of Red Amber Sorgo were infected, two were so blasted that they did not develop and two failed. In the three attempts to cause infection in the sorghum from India two failed and one was successful. In all, twenty-five infected heads resulted from thirty-three inoculations. Since the failures were with young stalks where the exact location of the growing point is difficult to determine, it is quite likely that a series of injections along the stem in that region would insure complete success.

When the infection takes place in individual ovaries in relatively late stages of flower formation, the smutted kernels are often greatly developed on one side (Pl. 7, Figs. 1–4). All stages from slightly smutted seed, where there is a relatively small amount of diseased tissue, to a complete smutting of the kernel have been observed. The extent of the diseased tissue in such cases seems to depend largely upon the stage of development of the kernel before the smut mycelium gained entrance.

DISCUSSION AND CONCLUSIONS

The experiments described clearly establish the fact that a hitherto unknown type of infection of sorghums by *Sphacelotheca cruenta* actually occurs. In addition to the general systemic infection, which results from the penetration of seedlings by germ tubes, we have a distinct local infection in which individual flowers, parts of panicles, or frequently entire panicles, are involved. The extent of this local infection evidently depends upon whether the smut spores reach the embryonic tissues in sufficient numbers at the proper stage of development. As already noted, systemic infection results in the production of characteristic pathological symptoms—the excessive dwarfing, tillering, production of heads, etc. Quite regularly all the panicles on such a plant are infected. In this new type of infection no general development of mycelium occurs in the host and the pathological symptoms just described are lacking. The growth of the mycelium is confined to the individual part—flower, panicle or branch—which is invaded. If this branch is removed, the plant will continue to produce only sound stems and panicles.

This local type of infection bears many resemblances to the conditions found in corn smut. In the latter, however, any embryonic tissue may be invaded and the mycelium appears to be strictly local in its cycle of development. The mycelium may develop in the tissues of roots, stems, leaves, ovaries and stamens, causing hypertrophy and later giving rise to spores. In our experiments, the formation of smut spores occurred only in the flowers of the sorghum, although the production of sori on the pedicels has been described.

There also are resemblances between this type of infection in sorghum and the "shoot infection" described by Hecke (**5**). As already noted, the latter was able to secure the infection of the young buds of *Secale montanum* by the spores of *Urocystis occulta*. The shoots which resulted from these buds gave rise to the characteristic pathological symptoms of the smut. The same thing occurred in young shoots of *Lychnis alba* when inoculated with the spores of *Ustilago violacea*. In our experiments the infection appeared to be confined to smaller portions of the shoot system. It is possible, however, that if injections were made in

still earlier stages, larger portions of the resulting shoots would be involved.

It is interesting to consider why Brefeld (**1, 2**) failed to obtain smutted panicles in his experiments in which he poured conidia into the cornucopia of sorghum plants 5 inches to 2 feet high. The probable explanation is that the conidia were unable to reach the embryonic bud of the plant. The young leaves on the stem of sorghum are so arranged that spores poured in would be prevented from actually reaching the growing point.

The modes of infection of sorghums by *Sphacelotheca cruenta* are quite varied. We have not only the general systemic infection through seedlings but also local types of infection as well as a type of shoot infection. A further interesting question arises, whether we have a blossom infection such as occurs in the loose smut of wheat and barley. Brefeld and Falck (**4**) were unable to obtain any evidence on this point. Our own experiments have not been carried out sufficiently to determine whether a typical blossom infection occurs.

Since plants infected in the seedling stage by *Sphacelotheca cruenta* head out prematurely and consequently the spores are readily distributed, the question may be raised as to how the spores get in contact with the ripe seed, and thus be carried over to the next planting season. Undoubtedly the greatest number of spores produced are distributed far and wide and do not come in contact with ripe grain. A considerable proportion, however, remain in the smutted head and if the latter is gathered and threshed with the sound heads the kernels may be contaminated.

The premature heading of these infected plants, however, also makes it possible for the spores produced in such heads to be carried to the immature panicles and lateral buds of neighboring plants. Our experiments and field observations have demonstrated that a considerable percentage of plants inoculated in this way may develop loose smut in individual kernels or throughout the entire head. This mode of infection occurred in our experiments under conditions comparable to field plantings of contaminated seed. When a few individual kernels of an otherwise sound head are smutted, the spores from these are likely to be spread over the adjacent normal grains and the chances that the fungus

will be carried to the succeeding crop are increased. No doubt this mode of infection may be responsible for some of the losses due to the loose kernel smut but its economic importance can be determined only by extensive field experiments.

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EXPLANATION OF PLATES

PLATE 5

Secondary infection of Valley Kaoliang (S.N. 192) by *Sphacelotheca cruenta* in the field.

Fig. 1. Terminal head normal; smutted panicles on lateral branches from second and fourth nodes from the top of the plant; normal panicle on lateral branch from third node.

Fig. 2. Terminal head normal; smutted panicle on lateral branch from third node.

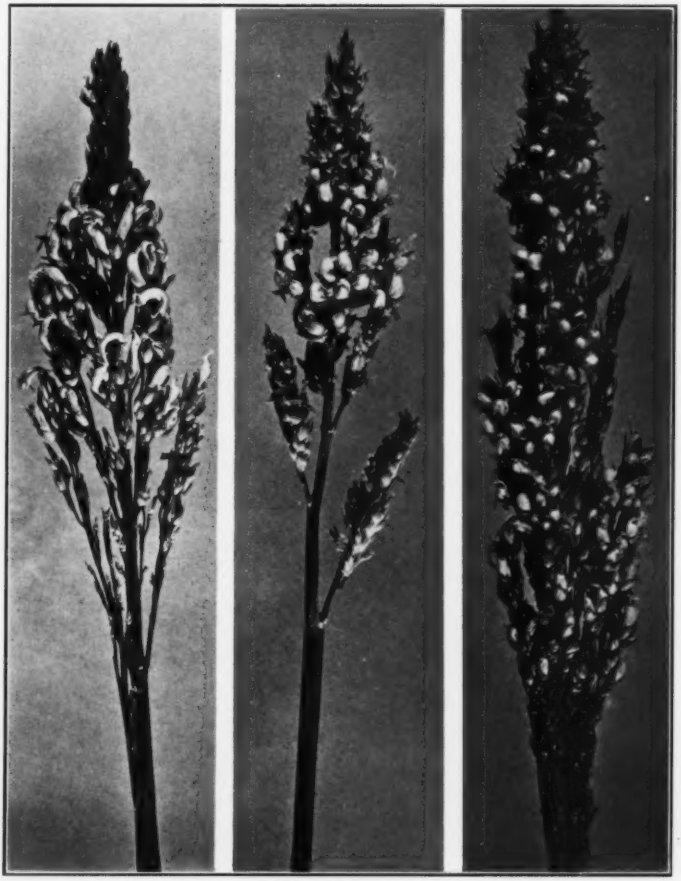
Fig. 3. Terminal head normal; normal panicle on lateral from second node; smutted panicles from third and fourth nodes.

PLATE 6

Secondary infection of sorghums by *Sphacelotheca cruenta* experimentally produced. In each case a number of flowers have become infected and given rise to the smut balls. The normal kernels are still small and inconspicuous.

1 2 3

VALLEY KAOLIANG INFECTED BY SPHACELOTHECA CRUENTA



1 2 3

SORGHUMS INFECTED BY SPHACELOTHECA CRUENTA

1 2

3 4

SECONDARY INFECTION OF SORGHUMS BY SPHACELOTHECA CRUENTA

Fig. 1. Valley Kaoliang (S.N. 192).
Fig. 2. Blackhull Kafir (S.N. 223).
Fig. 3. Darso (S.N. 225).

PLATE 7

Secondary infection of sorghums by *Sphacelotheca cruenta* experimentally produced.

Figs. 1, 3. Enlarged (1½ times) smut balls on Blackhull Kafir (S.N. 223).
Figs. 2, 4. Enlarged (1½ times) smut balls on Valley Kaoliang (S.N. 192).

NEW SPECIES OF FUNGI[1]

G. BRESADOLA

Corticium apiculatum Bres. n. sp.

Late effusum, membranaceum, cremeum, margine albo, subfimbriato, hymenio laeve, demum laxe areolato-diffracto; sporis oblongis, valde apiculatis, hyalinis, 5–6 x 3 μ; basidiis clavatis, 40–45 x 7–8 μ; hyphis tenuibus, septatis, saepe ad septa nodosis, 4–7½ μ.

Hab. ad truncos *Alni tenuifoliae*, Idaho. (*Weir 23304.*)

Obs. Habitu *Corticio laevi* valde simile, sed sporis et structura diversum.

Corticium areolatum Bres. n. sp.

Late effusum, subceraceum, arcte adnatum ex albo subalutaceum, margine pruinato; hymenio dense areolato-diffracto; sporis hyalinis, subellipticis, uno latere depressis, 7–9 x 4–5 μ; basidiis clavatis, 24–25 x 6–7 μ; hyphis irregularibus, septato-nodosis, 1½–3 μ, cystidiis nullis.

Hab. ad ramos *Alni tenuifoliae*, Idaho. (*Weir 23387.*)

Obs. Von Aussehen scheint ganz *Corticium scutellare* Berk. et C., aber dieser nach Ex. aus America ist eine *Peniophora* mit kleineren Sporen und grösseren Hyphen.

Corticium consimile Bres. n. sp.

Late effusum, tenue, pelliculare, ex albo flavidulum, margine subsimilare; hymenio laevi, haud rimoso; sporis hyalinis, 4–4½ x 2–2½ μ; basidiis clavatis, 15 x 4 μ; hyphis tenuibus, septatis, vix nodosis, 2½–4, aliqua inflata 6 μ.

Hab. ad truncos decorticatos *Laricis occidentalis*, Idaho. (*Weir 10808.*)

Obs. Von *Corticium decipiens* v. Höhn. et Litsch. durch kleinere Sporen und unregelmässigen Hyphen verschieden.

[1] This paper was sent to me by the author for publication. The descriptions of the new species are based on material in my herbarium and are the result of an extended correspondence and exchange of specimens with G. Bresadola.—JAMES R. WEIR.

Corticium furfuraceum Bres. n. sp.

Latissime effusum, vix 100–150 μ crassum, furfuraceum, pallidum, demum subalutaceum, margine pruinato; hymenio fatiscente; sporis hyalinis, 4–6 x 2½–3 μ; basidiis 8–10 x 4–5 μ; hyphis conglutinatis, indistinctis.

Hab. ad ligna *Thujae plicatae*, *Abietis grandis*, *Laricis occidentalis*, *Pini monticolae*, Idaho. (*Weir 17211*, *16764*, *16927*.)

Obs. Aussehen fast von *Corticium botryosum* Bres. aber Struktur und Sporen ganz verschieden.

Corticium subapiculatum Bres. n. sp.

Late effusum, arcte adnatum, ceraceum, ex alutaceo fulvescente, margine albo, pruinato; hymenio laevi, haud rimoso; sporis hyalinis, oblongis, breviter apiculatis, 6–7 x 3–3½ μ; basidiis clavatis, 25–26 x 4–6 μ; hyphis tenuibus, septato-nodosis, 3–4½ raro 6 μ.

Hab. ad truncos *Pini*, Idaho. (*Weir 16928*.)

Obs. Dem *Corticium confluens* Fr. sehr verwandt, aber gut verschieden.

GLOEOCYSTIDIUM POLYGONIUM (Pers.) var. **fulvescens** Bres. n. var.

Orbiculare, dein confluens et late effusum, arcte adnatum, fulvellum, margine subfimbriato, albo; hymenio laevi, applanato; sporis cylindraceo-curvulis, hyalinis, 6–9 x 2½–3 μ; basidiis 30–35 x 6–8 μ; gloeocystidiis immersis, clavato-subcapitatis, flavis, 36–40 x 24–28 μ; hyphis irregularibus, flexuosis, 4–5 μ crassis.

Hab. ad corticem *Populi trichocarpae*, Idaho. (*Weir 16824*, *14561*.)

Obs. Von Type durch Form und Farbe ganz verschieden. Nur die mikroscopische Merkmalen sind gleich.

Peniophora albo-straminea Bres. n. sp.

Orbicularis, dein confluens et late effusa, tenuis, subceracea, ex albo straminea, margine pruinato; hymenio laevi, rimoso; sporis ellipticis, hyalinis, 6–7½ x 4–4½ μ; basidiis clavatis, 24–25 x 6–8 μ; cystidiis clavatis, laevibus, 80–105 x 6–9 μ; hyphis conglutinatis, irregularibus, 1½–6 μ.

Hab. ad corticem *Alni tenuifoliae*, Idaho. (*Weir 17069*, *16818*.)

Obs. Dem *Peniophora cremea* verwandt, aber durch Sporen und Struktur ganz verschieden.

Peniophora gilvidula Bres. n. sp.

Latissime effusa, arcte adnata, ceracea, gilvidula, margine e pruinato similari; hymenio laevi, aetate hic illic rimoso; sporis hyalinis, 1-guttulatis, 6–7 x 3–4 μ; basidiis clavatis, 30–35 x 6 μ; cystidiis subfusoideis, 120–150 x 6–8 μ, laxe granuloso-scabris; hyphis indistinctis, aliqua visa 3–4, tenuibus.

Hab. ad ligna *Pini ponderosae*, Montana. (*Weir 23305.*)

Obs. In der Nähe von *Peniophora albostraminea.*

Peniophora lepida Bres. n. sp.

Late effusa, ceraceo-membranacea, $\frac{1}{2}$ mm. crassa, isabellina, margine demum libero, revoluto; hymenio laevi, pulverulento; sporis non inventis; basidiis 45–50 x 8–9 μ; cystidiis 70–90 x 7–9 μ; hyphis septato-nodosis, 2–4$\frac{1}{2}$ μ.

Hab. ad truncos emortuos *Salicis* sp., Idaho. (*Weir 16744, 15003.*)

Obs. Scheint *Corticium lepidum* Romell, aber Struktur verschieden.

Peniophora rhodochroa Bres. n. sp.

Late effusa, ceraceo-membranacea, subiculo albo, tenui, tomentoso, margine fimbriato, hymenio laevi, *luride roseo;* sporis hyalinis, 1-guttulatis, oblongis, 6–6$\frac{1}{2}$ x 3–3$\frac{1}{2}$ μ; basidiis clavatis, 26–28 x 6–7 μ; cystidiis fusoideis vel clavatis, granuloso-obtectis, 60–75 x 7–9 μ; hyphis tenuibus, septatis, ad septa interdum nodosis, 4–10 μ crassis.

Hab. ad ramos *Alni tenuifoliae*, Idaho. (*Weir 16809.*)

Obs. Der *Peniophora lepidae* verwandt.

Peniophora (*Gloeopeniophora*) **Weiri** Bres. n. sp.

Latissime effusa, arcte adnata, tenuis, subceracea, ochroleuca, margine similari; hymenio laevi, interrupte rimoso; sporis subellipsoideis vel piriformibus, hyalinis, 7–9 x 3–4 μ; basidiis clavatis, 24–25 x 6–7 μ; cystidiis subcylindraceis v. apice capitatis, laevibus, 80–110 x 4–7 μ; gloeocystidiis immersis, succo luteo repletis, 50–60 x 6–7 μ; hyphis tenuibus, irregularibus, septatis, interdum ad septa nodosis, 3–6 μ crassis.

Hab. ad truncos *Pini monticolae*, Idaho. (*Weir 23345.*)

Obs. Von Aussehen scheint *Corticium ochraceum* Fr. aber die Struktur ganz verschieden.

Aleurodiscus helveolus Bres. n. sp.

Erumpens, pulvinatus, rugulosus, ceraceus, helveolus, 2–3 mm. latus, ex hyphis tenuibus, irregularibus, septatis, interdum ad septa nodosis, 3–10 μ latis, conflatus; sporis hyalinis, obovato-oblongis, 18–21 x 6–9 μ; basidiis 2–4 sterigmatibus, 80–100 x 7–9 μ; paraphysibus irregularibus, undulato-restrictis, moniliformibus, laevibus, 3–6 μ crassis, apice interdum subcapitatis.

Hab. ad ramos *Salicis lasiandrae*, Washington. (*Weir 16312.*)

Obs. Structura hymenii ad *Aleurodiscum amorphum* accedit.

Aleurodiscus succineus Bres. n. sp.

Superficialis, convexus vel cupularis aut explanatus, ceraceus, succineus, expallens, 2–6 mm. longus, 2–8 mm. latus, $\frac{1}{2}$ mm. crassus, ex hyphis irregularibus, tenuibus, septatis, vix nodosis, 2–5 μ crassis conflatus; sporis non visis; basidiis clavatis, 120–150 x 6–8 μ, adhuc immaturis, paraphysibus superne aculeolatis, 3–7 μ crassis; gloeocystidiis immersis, subfusoideis, 75–100 x 8–10 μ.

Hab. ad *Arbutum Menziesii*, Oregon (*Weir 8682*).

Obs. *Aleurodisco croceo* Pat. videtur affinis, sed in isto de gloeocystidiis non fit sermo, nec noster erumpens, sed provsus superficialis est.

Odontia eriozona Bres. n. sp.

Late effusa, subiculo tomentosulo vix manifesto, margine evidenter tomentoso, albo; aculeis subulatis, distinctis vel basi 2–3 connatis, stramineis, 2–3 mm. longis; sporis obovatis, hyalinis, 4$\frac{1}{2}$ x 2$\frac{1}{2}$–3 μ; basidiis clavatis, 12–15 x 3–4 μ; hyphis homogeneis, 1$\frac{1}{2}$–2$\frac{1}{2}$ μ.

Hab. ad ramos, Alabama. (*Weir 19579, 19582.*)

Obs. *Odontiae stenodonti* Pers. affinis, sed subiculo, aculeis majoribus et sporis ovatis satis diversa.

Odontia furfurella Bres. n. sp.

Late effusa, subiculo tenui, albo, crustaceo-furfuraceo, margine similari; aculeis distinctis, ex albo stramineis, parvis, fere papilliformibus, apice plumulosis; sporis cylindraceo-curvulis, biguttulatis, 4–5 x 1–1$\frac{1}{2}$ μ; basidiis 9–12 x 3–4 μ; hyphis conglutinatis, septato-nodosis, 2–3 μ.

Hab. ad ramos *Pini virginianae*, Virginia. (*Weir 20064, 20087.*)

Obs. *Odontiae farinaceae* Pers. affinis, sed subiculo magis crustaceo et sporis prorsum diversis bene distincta.

Hydnum beneolens Bres. n. sp.

Caespitosum, ex albo cremeum vel ochraceum; pileolis numerosis, carnoso-fibrosis, imbricatis, spathulatis vel flabelliformibus, glabris, azonis, 2–18 cm. latis, 2–12 cm. longis, basi in corpum crassum vel stipitiformem coalitis; aculeis variabilibus, subulatis vel spathulatis aut lamelloso-conjunctis, in stipitem decurrentibus, caro alba, immutabilis, odore grato, amygdalino, sapore miti; sporis hyalinis, globosis vel subglobosis, 6–7½ x 5–6 μ; basidiis clavatis, 20–25 x 4–6 μ; hyphis hymenii conglutinatis, 2–6 μ; toto planta generatim globosa, 10–30 cm. diam.

Hab. ad truncos, Chile. (*M. R. Espinosa 30, Weir 16363.*)

Obs. *Hydno septentrionali* proximum, sed minor, aculeis magis variabilibus et sporis diversum.

Merulius armeniacus Bres. n. sp.

Crustaceo-adnato, mycelio albo, hic illic roseolo, membrana subhymenina flava; plicis poriformibus, angulatis aureis, in sicco toto armeniaco; sporis hyalinis, cylindraceo-subcurvulis, biguttulatis, 4–4½ x 1½–2 μ; basidiis subcapitatis, 20–22 x 4–5 μ; hyphis septatis, non nodosis, aliqua granuloso-tecta, 2½–4½ raro 5 μ.

Hab. ad truncos *Abietis grandis*, Idaho. (*Weir 15306.*)

Obs. *Merulio aureo* proximus, sed notis datis bene distinctus.

Merulius interruptus Bres. n. sp.

Resupinato-effuso, membranaceo, margine demum libero; membrana 1 mm. circiter crassa, albida; plicis interrupte manifestis; irregulariter plicoso-girosis, carneis; sporis hyalinis, cylindraceis, 4–5 x 2 μ; basidiis clavatis, 24–27 x 4–5 μ; hyphis mollibus, septato-nodosis, 4–6 μ crassis.

Hab. ad truncos *Liriodendri*, coll. *Shear 4013.* (*Weir 20743.*)

Obs. *Merulio rufo* proximus, sed membrana tenaciori, colore, modo crescendi etc. diversus.

Ganoderma (*Amauroderma*) **expallens** Bres. n. sp.

Pileo e castaneo pallido expallente, orbiculari vel reniformi, umbilicato, margine lobato, glabro, leniter zonato, 4–5 cm. lato; stipite centrali vel excentrico, saepe radicato, pallido, glabrescente, medullato farcto, 4–6 cm. longo, 3–5 mm. crasso; tubulis 3 mm. longis; poris concoloribus, angulatis, saepe pentagonis, 4

pro mm.; sporis stramineis, laevibus, globosis vel ellipticis, interdum inaequilateralibus, 8–10 x 7–9 μ; hyphis hymenii hyalinis, $1\frac{1}{2}$–$3\frac{1}{2}$ μ; pilei $1\frac{1}{2}$–4 raro $4\frac{1}{2}$ μ.

Hab. ad truncos, Uganda Africae, coll. Maitland. (*Weir 20219.*)

Ganoderma (*Amauroderma*) **rubeolum** Bres. n. sp.

Pileo orbiculari, glabro, plus minusve ruguloso, rubido, 3–8 cm. lato; substantia suberoso-coriacea, luride ochracea; stipite centrali vel excentrico, pruinoso, tereti vel compresso, subcavo, fuscidulo, 6–9 cm. longo, 5–6 mm. crasso; tubulis 4–5 mm. longis; poris minimis, rotundis, 6–7 pro mm. dissepimentibus obtusis, crassis; sporis pallidis, laevibus, subglobosis, 11–12 x 9–10 μ; hyphis hymenii pallidis vel luteis, majoribus crasse tunicatis, 3–8 μ; pilei 3–6 μ, sinuosis, crasse tunicatis, luteis.

Hab. ad truncos, Uganda Africae, coll. Maitland. (*Weir 20217.*)

Polyporus leucoxanthus Bres. n. sp.

Pileo dimidiato, interdum scalari-imbricato et postice resupinate producto, convexo, leniter ruguloso, pallido-alutaceo, subvelutine glabrato, 2–4 cm. lato et longo, 2–3 mm. crasso; substantia alba, coriaceo-suberosa; tubulis alutaceis, 1–2 mm. longis; poris subrotundis, ex albo-concoloribus, 4–5 pro mm.; sporis hyalinis, cylindraceis, subcurvulis, 4 x $1\frac{1}{2}$–2 μ; basidiis clavatis, 10–12 x 3–4 μ; hyphis hymenii homogeneis vel crassiuscule tunicatis, 2–$3\frac{1}{2}$ μ, pilei $1\frac{3}{4}$–4 μ.

Hab. ad truncos *Robiniae pseudacaciae*, Virginia., (*Weir 21127*) et ad truncos *Populi tremulae*, Rossia, Wasilienka.

Polystictus pallidulus Bres. n. sp.

Pileo membranaceo, flabelliformi, pallido vel subcrustulino pallescente, e subvelutino glabrato, longitudinaliter striato ruguloso ve, subsulcato-zonato, 2–4 cm. lato, 2–3 cm. longo, 2–3 mm. crasso; tubulis vix 1 mm. longis; poris minimis, subrotundis, 6–7 pro mm., albo-stramineis; sporis non inventis; hyphis hymenii homogeneis, $1\frac{1}{2}$–3, pilei 1–$6\frac{1}{2}$ μ, majoribus tenuibus vel crassiuscule tunicatis.

Hab. ad truncos in Brasilia (Rick) et Cuba (Hioram). (*Weir 17687, 21035.*)

Dem *Polystictus elongatus*, *P. prolificans*, etc., verwandt, aber durch Poren ganz regelmässig und ohne Cystiden sehr gut verschieden.

Polyporus subcapucinus Bres. n. sp.

Pileo suberoso-lignoso, dimidiato-sessili, convexo, velutino, saepe margine lobato, late zonato-sulcato, rufo-fusco, 2–4 cm. lato et longo, 3–5 mm. crasso; tubulis 2–3 mm. longis; poris parvis, subrotundatis, 5–7 pro mm., fuscis; sporis luride luteolis, 3½–4 x 2½–3 μ; hyphis hymenii 2–3½, pilei 2½–6 μ, saepe abrupte restrictis.

Hab. ad truncos, Brasiliae. (*Weir 21026–C. G. Lloyd 10769.*)

Dem *Polyporus capucinus* Mont. verwandt, aber von Aussehen scheint fast gleich der *Trametes scleromyces* Berk.

Trametes cerina Bres. n. sp.

Pileo suberoso, dimidiato, postice resupinato producto, puberulo, 2–3 cm. lato, 1 cm. circiter longo, cervino; tubulis concoloribus, 3–4 mm. longis; poris 3/4 mm. latis, subrotundis, dissepimentibus oblongis, concoloribus; sporis oblongis, hyalinis, 12–15 x 5½–6 μ; basidiis clavatis, 20–24 x 5–6 μ; hyphis hymenii 2–3 μ; pilei 2–4 raro 4½ μ, flavidis.

Hab. Cuba. (*Weir 17749.*)

Obs. *Trameti ochroflavae* proxima, sed multo minor.

Trametes rubricosa Bres. n. sp.

Resupinata, subiculo obsoleto, fusco-purpurea; tubulis 4–6 mm. longis; poris rotundatis vel elongatis ½–1½ mm. latis; sporis non inventis; basidiis 12 x 4 μ; cystidiis 18–20 x 4–7 μ, apice muricellatis, dein laevibus; hyphis subhymenialibus hyalinis, tenuibus, septato-nodosis, 2–3 μ; contextus stramineis, septatis, 2–4 μ.

Hab. ad ramos *Juniperi monospermae*, New Mexico. (*Weir 18496, 17307.*)

Der *Trametes micans* verwandt, aber durch Farbe, durch Poren viel mehr grösser und Cystidien gut verschieden.

Trametes subcervina Bres. n. sp.

Pileo dimidiato-sessili, saepe resupinato producto, convexo, e pubescente glabrato, luride subcervino, 2–3 cm. lato, 1–2 cm. longo, 4½–6 mm. crasso; substantia suberoso-coriacea, concolore; tubulis 3–5 mm. longis; poris subrotundis vel oblongis, 2 pro mm. vel 2 x 1 mm.; sporis (?) 10–12 x 4–5 μ; hyphis hymenii pallidis, irregularibus, 1½–4 μ; pilei 2–4, aliqua inflata 5–6 μ.

Hab. ad truncos Brasiliae, Rick. (*Weir 19396.*)

Dem *Polyporus melleo-fulvus* Romell verwandt, der auch *Trametes* sp. ist.

Poria crustulina Bres. n. sp.

Longe lateque effusa, crustulina, subiculo subtenui, albo, margine albo tomentoso, demum subsimilari; tubulis 2–3 mm. longis; poris ut plurimum angulatis, 2–3 raro 4 pro mm.; sporis hyalinis, cylindraceo-curvulis, basi saepe subuncinatis, 6–9 x 3–3½ μ; basidiis clavatis, 15–20 x 4–6 μ; hyphis ex parte tenuibus, septatis, raro nodosis et ex parte crasse tunicatis, 2–4 raro 5 μ crassis.

Hab. ad truncos *Piceae Engelmanni* et *P. sitchensis*, Washington, Montana. (*Weir 1064, 8162, 15025, 15101.*)

Diese Art ist von der Verwandtschaft von *Poria luteo-alba*, *P. levis* und *P. hibernica*, aber durch Farbe, Sporen und Struktur ganz verschieden.

Poria dichroa Bres. n. sp.

Resupinata, albo-fuscescens, mollis, in plagulas ellipsoideas distributa, subiculo plus minusve crassiusculo, fulvo, margine elevato, interdum breviter reflexo, villosulo; tubulis 1–2 mm. longis; poris angulatis, mediocribus, ore demum fimbriatis, 3–4 pro mm.; sporis hyalinis, cylindraceo-curvis, 5½–6 x 1½–1¾ μ; hyphis hymenii hyalinis, 2½–3½ μ; subiculi fulvis, 3–3½, raro 4 μ, homogeneis.

Hab. ad truncos *Pini contortae*, *Abietis grandis*, *Tsugae heterophyllae* et *Pseudotsugae taxifoliae*, Idaho, Montana. (*Weir 12074, 16081, 12926, 16082.*)

Diese Art steht in der Nähe von *Poria levis* und *Poria luteo-alba* (Karst.) Sacc. aber ganz verschieden, besonders durch Subiculum immer vorhanden und colorirt.

Poria fagicola Bres. n. sp.

Effusa, ex albo pallide straminea, subiculo tenui, albo, margine albo-pruinoso; tubulis vix 1 mm. longis; poris irregularibus saepe angulatis, 3–4 pro mm., dissepimentibus obtusis; sporis hyalinis, subellipticis, 4–4½ x 2–2½ μ; basidiis clavatis, 12–15 x 3–4 μ; hyphis septatis, non nodosis, tenuibus, subirregularibus, 3–9 μ crassis.

Hab. ad truncos *Fagi ferrugineae*, Washington, D. C. (*Weir 19070.*)

Ganz in der Nähe von *Poria mucida* Pers. aber durch kleinere Sporen und Hyphen viel breiter verschieden.

Poria fulvella Bres. n. sp.

Late effusa, tenuis, e luteo-fulvella, subiculo nullo, margine pruinoso, albido, mox similari; tubulis ½–1 mm. longis; poris variantibus, subrotundatis, angulatis vel oblongis, ½–1 mm. latis, dissepimentibus obtusis; sporis hyalinis, subellipticis, 6–7½ x 3–3½ μ; basidiis clavatis, 15–18 x 5–6 μ, 2–4 sterigmatibus; sterigmatibus 3–4 μ longis; hyphis tenuibus, ramosis, 2–4 raro 5 μ crassis.

Hab. ad truncos *Pini contortae*, Idaho. (*Weir 17043.*)

Dem *Poria bombycina* verwandt, aber durch Farbe und kleinere Sporen verschieden. Bei *Poria bombycina* die Sporen sind 6–8 x 5 μ und die Farbe gelbbraun.

Poria proxima Bres. n. sp.

Late effusa, substrato tenui, albo, margine subfimbriato; tubulis vix efformatis; poris impressis, irregularibus, rotundatis, angulatis v. oblongis, 2–4 pro mm., alutaceis; sporis hyalinis, oblongis, 5½–7 x 3–4½ μ; basidiis clavatis, 24–26 x 5–6 μ; cystidiis clavatis, granuloso-scabris, 24–50 x 5–7 μ; hyphis contextus 2–5 μ crassis, septatis, non nodosis, crassiuscule tunicatis.

Hab. ad truncos *Hicoriae albae*, Indiana. (*Weir 3479.*)

Obs. Videtur *Poriae mucidae* Pers. proxima et praecipue praesentia cystidiorum diversa.

Poria similis Bres. n. sp.

Late effusa, tenui, margine pruinoso, e luride alba alutacea; tubulis vix manifestis, poris impressis, dissepimentibus obtusis, 4–6 pro mm.; sporis 4–4¾ x 3–3½ μ; basidiis 15–18 x 4–5 μ; cystidiis clavatis, furfuraceis, 15–25 x 6–9 μ; hyphis contextus 1½–4 μ, septatis, raro nodosis, tenuiter tunicatis.

Hab. ad truncos *Populi trichocarpae*, Coolin, Idaho. (*Weir 11565.*)

Obs. *Poriae corticolae* valde similis, sed sporis minoribus et praesentia cystidiorum bene distincta.

Poria vicina Bres. n. sp.

Late effusa, ex albido lignicolor, subiculo tenui, a'bo, margine e pruinato similari; tubulis 1–4 mm. longis; poris subrotundis v.

angulatis, 2–3 pro mm.; sporis hyalinis, oblongis, subellipticis, 6–8 x $3\frac{1}{2}$–4 μ; basidiis clavatis, 12–15 x 4 μ; cystidiis capitato-furfuraceis, 15 x 9 μ, capitulo deterso, 9 μ crasso; hyphis subirregularibus, septatis, non nodosis, tenuiter tunicatis, $1\frac{3}{4}$–$3\frac{1}{2}$ μ.

Hab. ad truncos *Abietis grandis*, Idaho, Washington. (*Weir 11541, 12077, 16085.*)

Von Aussehen dem *Poria crustulina* ähnlich, aber durch Sporen und Context verschieden und mehr dem *Poria subacida* verwandt.

Poria zonata Bres. n. sp.

Valde effusa, alba, demum straminea, margine zona membranacea, sterili cincta, subiculo membranaceo, $\frac{1}{2}$ mm. crasso; tubulis 1–3 mm. longis; poris majusculis, irregularibus, 1–2 mm. latis; sporis cylindraceo-curvulis, hyalinis, biguttulatis, 5–6 x 2–$2\frac{1}{2}$ μ; basidiis clavatis, 18–20 x $3\frac{1}{2}$–$4\frac{1}{2}$ μ; cystidiis ventricoso-cuspidatis, furfuraceo obductis, 45–46 x 15–18 μ; hyphis tenuibus, laxe septatis, 2–4 μ, juxta septa interdum uno latere incrassatis.

Hab. ad truncos *Abietis grandis*, Idaho. (*Weir 15910.*)

Dem *Poria radula* von Aussehen ganz gleich, aber, besonders durch Sporen, gut verschieden.

Lentinus dentatus Bres. n. sp.

Pileo infundibuliformi, glabro, e centro ad marginem dense striato sulcato, castaneo-fusco v. cacaino, margine dentato, 2–3 cm. lato; lamellis decurrentibus, umbrinis; acie integra, stipite tereti, cavo, concolori, tomentoso-hirto, 3–5 cm. longo, 2–3 mm. crasso; sporis non inventis; basidiis 30 x 4–5 μ; hyphis contextus lamellarum $1\frac{1}{2}$–3 μ, homogeneis, tenacibus.

Hab. Brasilia. (*Weir 14364.*)

Obs. *Lentino velutino* affinis, sed pileo glabro sulcato optime diversus.

TRENTO, ITALY.

CULTURE EXPERIMENTS WITH HETEROECIOUS RUSTS IN 1922, 1923 AND 1924

W. P. Fraser

Culture experiments with heteroecious rusts were continued in 1922, 1923 and 1924. The following are some of the more interesting results. Inoculations were made with telial material by first placing it in a moist chamber until the telia were producing basidiospores. Pots containing the plants to be infected were placed in inoculation boxes and the material bearing the germinating telia was suspended over the potted plants. The plants were sprayed with water and left in the inoculation box for about forty-eight hours. The same method was followed when aecial material was used, but it was suspended at once over the plants to be tested. The grasses used were grown in the greenhouse from seed or in a few cases from plants taken in the previous season.

Puccinia Clematidis (DC.) Lagerh.

In 1922 inoculations with abundant aecia in good condition from *Anemone cylindrica* and *A. globosa* were made on a number of grasses. Very heavy infection resulted with the development of uredinia and telia on *Agropyron tenerum*, *A. spicatum*, *A. dasystachyum* and *E. canadensis*. There was only a moderate infection on *Elymus virginicus* and *Hystrix patula;* weak infection on *Elymus curvatus* and no infection on *Bromus Pumpellianus*, *Festuca elatior*, *Poa pratensis*, *P. compressa* and *Triticum aestivum*. Inoculations with the uredospores from the culture on *Agropyron dasystachyum* produced weak infection on *Elymus curvatus* and *E. robustus*, and negative results on *Agropyron Smithii* and *Hordeum jubatum*.

In 1923 inoculations with aecia on *Anemone globosa* and *A. cylindrica* produced heavy infection on *Agropyron spicatum*, *A. Richardsonii;* moderate infection on *Elymus canadensis* and *E. diversiglumis;* weak infection on *Elymus curvatus*, and negative results on *Agropyron repens*, *Bromus ciliatus*, *B. Pumpellianus* and *Elymus innovatus*.

Aecia on *Actaea* collected at Winnipeg gave good infection on *Hystrix patula*.

Puccinia Clematidis, as it has been regarded by Arthur, is a species consisting of several biological races all having aecia on Ranunculaceae. Much culture work must be done before the limits of the various races will be known. Several races, however, are indicated.

A race with aecia on *Actaea* and telia on *Hystrix* and some species of *Elymus*, chiefly *E. virginicus* and *E. canadensis*.

A race with aecia on *Anemone* and telia on several species of *Agropyron* and *Elymus*.

The form of *Puccinia Clematidis* with many-celled teliospores, which has been collected on *Bromus ciliatus* and *B. latiglumis* from southern Manitoba to northern Saskatchewan, is a distinct race with aecia on *Thalictrum* (see Mycologia **12**: 292–294. 1920). Probably it should be regarded as a distinct species.

Field evidence also suggests a distinct race with two-celled teliospores on *Bromus* (chiefly *B. ciliatus* and *B. Pumpellianus*). The aecia are also on *Thalictrum*.

It seems probable also that there is another race with telia on *Elymus canadensis*, *E. curvatus* and *E. Macounii*.

Field evidence also suggests a race with aecia on *Halerpestes Cymbalaria*, and telia on *Puccinellia*.

The aecia on *Ranunculus* collected in Western Canada as far as tested belong to the closely related *Uromyces Alopecuri* Seym., on *Alopecurus aristulatus*. (See Mycologia **11**: 129–130. 1919.) In Eastern Canada aecia on *Ranunculus acris* are connected with *P. Clematidis* on *Alopecurus pratensis*. (See Mycologia **4**: 179. 1912.)

PUCCINIA CORONATA CDA.

Arthur has placed the coronate forms of *Puccinia* on various grasses and the aecia on *Rhamnus*, *Elaeagnus* and *Lepargyraea* under *Puccinia coronata* Cda. Considerable cultural work has been done by investigators in Europe and America which shows the relationships of the aecia on *Rhamnus*, but as far as the author is aware no cultures have been made to establish the connections of the aecia on *Lepargyraea* [1] and *Elaeagnus*. They have

[1] Since the above was written I have learned that Bethel made cultural

usually been referred to *Aecidium Allenii* Clinton. Aecia on *Rhamnus cathartica*, *Lepargyraea canadensis*, *L. argentea* and *Elaeagnus commutata* are usually abundant in the districts around Saskatoon, and collections of aecia have been made on *Rhamnus alnifolia*, the only native *Rhamnus* in Saskatchewan. Coronate forms of *Puccinia* are common on *Avena sativa*, *A. fatua* and *Scolochloa festucacea*, the latter grass being very common in the sloughs of Saskatchewan. Collections have also been made on *Agropyron tenerum*, *Beckmannia erucaeformis*, *Bromus ciliatus*, *B. Pumpellianus*, *Deschampsia caespitosa*, *Elymus canadensis*, *Calamagrostis canadensis*, *C. inexpansa* and *C. elongata*. It seemed important to determine the relationships of these forms, especially their relationship to the form of *Puccinia coronata* Cda. on oats.

The silverberry, *Elaeagnus commutata*, is very common on the prairies of central and northern Saskatchewan and nearly every season is very heavily covered with aecia. In 1922 aecia were obtained in great abundance and in excellent condition near Saskatoon and inoculations were made on a number of grasses, but without result. In the spring of 1923 strong field evidence was secured that the aecia on *Elaeagnus* were connected with a coronate *Puccinia* on *Calamagrostis inexpansa* A. Gray. Telia collected on this host in the spring gave excellent germination and inoculations were made in the greenhouse on *Lepargyraea canadensis*, *L. argentea* and *Elaeagnus commutata*. There was no infection except on *Elaeagnus commutata* (two plants) which developed pycnidia in ten days and aecia sixteen days after inoculation. Inoculations were also made with aecia from *Elaeagnus commutata*, collected at Saskatoon on two pots of *Calamagrostis inexpansa*. Heavy infection followed with abundant development of uredinia and telia. The experiments with

studies of the aecia on *Lepargyraea canadensis* several years ago. He has generously given me permission to state his unpublished results. Using aecia from *Lepargyraea canadensis* he obtained good infection on *Bromus Pumpellianus*, *B. ciliatus*, *Agropyron* spp., *Calamagrostis canadensis* and *Trisetum subspicatum*. He also obtained aecia on *Lepargyraea canadensis* using telia from all of these grasses. The uredinia and telia on the grasses were almost identical with those of *Puccinia coronata*. Though cultures were not made with aecia from *L. argentea* yet from field evidence he believes that the form on *L. argentea* is identical with that on *L. canadensis*.

aecia were repeated in 1924 with like results. During the years 1922, 1923 and 1924 the following grasses were inoculated with aecia with negative results: *Agropyron dasystachyum*, *A. tenerum*, *A. Richardsonii*, *A. Smithii*, *A. spicatum*, *Alopecurus aristulatus*, *Avena sativa*, *Beckmannia erucaeformis*, *Bromus ciliatus*, *B. latiglumis*, *B. Porteri*, *B. Pumpellianus*, *Calamagrostis canadensis*, *C. elongata*, *Deschampsia caespitosa*, *Elymus curvatus*, *E. canadensis*, *E. diversiglumis*, *E. innovatus*, *Hordeum jubatum*, *Koeleria gracilis*, *Lolium perenne*, *Scolochloa festucacea*, *Sporobolus cryptandrus*, *Stipa viridula* and *Torresia odorata*. There was no evidence of flecking or infection on any of the grasses and no trace of infection on *Avena sativa*, though inoculations on several pots were made each year.

It would seem from these experiments that the form of *Puccinia coronata* having aecia on *Elaeagnus* is highly specialized, having telia on *Calamagrostis inexpansa* and aecia on *Elaeagnus commutata*. This rust has been cultured in the greenhouse on *Calamagrostis inexpansa* for several months, so that without doubt it is a very congenial host.

The buffalo-berry, *Lepargyraea canadensis* (L.) Greene, which is common in northern Saskatchewan usually shows abundant aecia every season. Field evidence very strongly indicated its connection with a coronate *Puccinia* on *Bromus ciliatus*, and there was some evidence that it was also connected with telia on *Agropyron tenerum* and *Elymus canadensis*. Excellent material was obtained in the spring of 1924 and inoculations were made on a number of grasses with heavy infection on *B. ciliatus*, *B. Porteri* and *B. latiglumis;* moderate infection on *Phalaris arundinacea*, *Calamagrostis inexpansa* and *Beckmannia erucaeformis*, and slight infection on *Agropyron Richardsonii*, *A. spicatum* and *Bromus Pumpellianus*. There were no results from inoculations on *Avena sativa*, *Calamagrostis canadensis*, *C. elongata*, *Elymus canadensis*, *E. diversiglumis*, *Scolochloa festucacea*. Further inoculations were made with urediniospores developed from these cultures with moderate infection on *Lolium multiflorum;* weak infection on *Agropyron dasystachyum* and *Festuca viridula*, and no infection on *Deschampsia caespitosa*, *Scolochloa festucacea* and *Hystrix patula*. From these experi-

ments it would seem that the aecia on *Lepargyraea canadensis* in central and northern Saskatchewan are connected with a form of *Puccinia coronata* on *Bromus*, and that under very favorable conditions uredinia and telia may develop on *Phalaris arundinacea*, *Beckmannia erucaeformis* and several other grasses. This form has been cultured in the greenhouse for several months on *Bromus Porteri*, *B. latiglumis*, and *B. ciliatus*, so there is no doubt these are congenial hosts.

Davis (Trans. Wisc. Acad. Sci. **21**: 299–301. 1924) described culture experiments which indicate that the aecia on *Lepargyraea canadensis* (L.) Greene in Wisconsin are connected with a rust on a sedge which he described as *Puccinia Caricis-shepherdiae*. There seems no doubt, however, from the cultures and field observations described here that the aecia on *Lepargyraea canadensis* in Saskatchewan are connected with a coronate rust with uredinia and telia chiefly on *Bromus*.

Aecia were collected on *Rhamnus alnifolia* near Saskatoon. Inoculations on *Calamagrostis canadensis* and *Scolochloa festucacea* produced heavy infection with abundant uredinia and telia. Rather weak infection was obtained on *Bromus Porteri* and *Avena sativa*. Very small uredinia developed on the latter host followed by a few telia. There was no infection on *Elymus curvatus*.

Aecia on *Rhamnus cathartica* were collected near Saskatoon in 1924 and inoculations made on a number of grasses. Very heavy infection resulted on *Avena sativa* and *A. fatua* with abundant development of uredinia and telia; moderate infection on *Bromus Porteri* and *Festuca viridula*, and rather weak infection on *Alopecurus aristulatus*. There was no infection on *Agropyron tenerum*, *A. spicatum*, *Bromus Pumpellianus*, *B. ciliatus*, *Calamagrostis elongata*, *Deschampsia caespitosa*, *Elymus diversiglumis*, *E. curvatus*, *E. innovatus*, *Festuca elatior*, *Hordeum jubatum*, *Koeleria cristata*, *Hystrix patula*, *Muhlenbergia racemosa*, *Poa triflora*, *Sphenopholis obtusata*, *Torresia odorata* and *Carex filifolia*.

AECIDIUM ALLENII CLINTON

The buffalo-berry, *Lepargyraea argentea* (Nutt.) Greene, is common along the banks of the Saskatchewan near Saskatoon, and usually is attacked by the aecial stage of a rust. There was

an exceedingly heavy infection in 1922 and 1923 which suggested the alternate host to be growing near. Most careful examination was made of the grasses in the vicinity, but no field evidence whatever could be found to give a clue to the connection of the aecia. Inoculations were made on all the grasses that were likely to bear a connected telial form but without result. There was no indication whatever of infection on any of the grasses inoculated. The aecial material was abundant and in excellent condition. The following grasses were tested, with negative results: *Agropyron dasystachyum, A. Richardsonii, A. tenerum, A. repens, A. spicatum, A. Smithii, Avena sativa, Alopecurus aristulatus, Beckmannia erucaeformis, Bromus ciliatus, B. latiglumis, B. Porteri, B. Pumpellianus, Calamagrostis canadensis, C. inexpansa, C. elongata, Deschampsia caespitosa, Elymus canadensis, E. curvatus, E. innovatus, E. diversiglumis, E. Macounii, Festuca elatior, F. viridula, Torresia odorata, Scolochloa festucacea, Carex filifolia.*

From these cultural and field studies the writer is of the opinion that the aecia on *Lepargyraea argentea* do not belong to a form of *Puccinia coronata* Cda.

PUCCINIA SUBNITENS DIET.

Telia of *Puccinia subnitens* on *Distichlis spicata* were collected at Saskatoon. Inoculations on *Plantago eriopoda* Torr., and two pots of *Glaux maritima* L., were followed by pycnia and aecia. This confirms previous work. (See Mycologia **14**: 228. 1922.)

PUCCINIA ANGUSTATA PECK

Field evidence suggested the connection of a rust regarded as *Puccinia eriophori* Thüm. on *Eriophorum angustifolium* Roth., with aecia on *Lycopus asper* Greene. Collections of telial material on *Eriophorum angustifolium* were made at Saskatoon. The teliospores germinated freely and inoculations were made on *Lycopus asper, Mentha* sp. and *Senecio canus.* Very heavy infection followed on *Lycopus asper* but no infection on the others. The plants of *Mentha* and *Senecio* were not in a healthy condition, so the negative evidence is of little or no value. Arthur (Mycologia **8**: 131, 132. 1916) has shown that *Puccinia Eriophori* on

Eriophorum has aecia on *Senecio aureus* L. He points out that the morphological differences between *P. angustata* and *P. Eriophori* are not very marked. From a study of the material at hand it seemed to the writer that the rust collected on *Eriophorum angustifolium* and used in this culture was *P. angustata* rather than *P. Eriophori*.

PUCCINIA ANDROPOGONIS SCHW.

Aecia in excellent condition were collected on *Penstemon acuminatus* Dougl. near Saskatoon in 1924. Inoculations in three pots of *Schizachyrium scoparium* (Michx.) Nash resulted in the development of abundant uredinia and telia of *Puccinia Andropogonis* on all the plants inoculated. The check plants remained free from infection.

Arthur has shown by cultures many times that *Puccinia Andropogonis* has aecia on species of *Penstemon*. (See Mycologia **4**: 17. 1912.)

GYMNOSPORANGIUM JUVENESCENS KERN

Telia of *Gymnosporangium juvenescens* collected at Saskatoon on *Sabina horizontalis* (Moench) Rydb. were germinated in a moist chamber. Inoculations on *Amelanchier alnifolia* Nutt., and *Crataegus chrysocarpa* Ashe, resulted in very heavy infection with abundant development of pycnia and aecia on *Amelanchier alnifolia*, but no infection on *Crataegus*. Arthur (Mycologia **4**: 61, 62. 1912) previously established this connection by cultures.

GYMNOSPORANGIUM CORNICULANS KERN

Inoculations with germinating telia from *Sabina horizontalis* collected at Saskatoon infected *Amelanchier alnifolia* heavily, but failed to infect *Crataegus chrysocarpa*. This connection was previously established by Arthur (Mycologia **2**: 235–236. 1910.)

MELAMPSOROPSIS PYROLAE (DC.) ARTH.

Germinating telia were collected on *Pyrola asarifolia* at Duck Lake, Sask., and inoculations were made on the cones of *Picea canadensis* growing on the grounds of the University of Saskatchewan on June 5. The branches bearing the cones were then enclosed in celluloid cylinders and kept moist and shaded for

two days. Pycnia appeared on June 30 on one cone that had been inoculated, followed by aecia, which were shedding spores on August 23. There was no infection on the cones on the surrounding trees. The cones were rather young when inoculated and this may account for the scant infection. Previous experiments indicated that better infection was secured when the cones were well developed at the time of inoculation.

(The work of the cultures was largely performed by members of the staff of the Dominion Laboratory. The writer wishes to acknowledge this aid, especially that of Messrs. P. M. Simmonds, R. R. Hurst and R. C. Russell. Acknowledgment is also made of the determination of several grasses by Dr. M. O. Malte of Ottawa.)

SUMMARY

Puccinia Clematidis (DC.) Lagerh. Inoculations with aeciospores from *Anemone cylindrica* A. Gray and *A. globosa* Nutt. infected heavily *Agropyron tenerum* Vasey, *A. spicatum* (Pursh) Scribn. & Smith, *A. dasystachyum* (Hook.) Scribn., *A. Richardsonii* (Trin.) Schrad., and *Elymus canadensis* L., and rather weak infection on a number of other grasses.

Inoculations with aeciospores from *Actaea* sp. readily infected *Hystrix patula* L.

Puccinia coronata Cda. Teliospores from *Calamagrostis inexpansa* A. Gray infected heavily *Elaeagnus commutata* Bernh. Aeciospores from *Elaeagnus commutata* infected heavily *Calamagrostis inexpansa*.

Aeciospores from *Lepargyraea canadensis* (L.) Greene infected heavily *Bromus ciliatus* L., *Bromus Porteri* (Coult.) Nash, and *Bromus latiglumis* (Shear) Hitchc., and weakly infected a number of other grasses.

Aeciospores from *Rhamnus alnifolia* L'Her infected heavily *Calamagrostis canadensis* L., and *Scolochloa festucacea* (Willd.) Link, and rather weak, a number of other grasses.

Aeciospores from *Rhamnus cathartica* L. infected heavily *Avena sativa* L., *A. fatua* L., and rather weak, a number of other grasses.

Puccinia subnitens Diet. Teliospores from *Distichlis spicata* Coult. & Nels. infected heavily *Plantago eriopoda* Torr. and *Glaux maritima* L.

Puccinia angustata Peck. Teliospores from *Eriophorum angustifolium* Roth. readily infected *Lycopus asper* Greene.

Puccinia Andropogonis Schw. Aeciospores from *Penstemon acuminatus* Dougl. infected heavily *Schizachyrium scoparium* (Michx.) Nash.

Gymnosporangium juvenescens Kern. Teliospores from *Sabina horizontalis* (Moench) Rydb. infected *Amelanchier alnifolia* Nutt.

Melampsoropsis Pyrolae (DC.) Arth. Inoculations with teliospores from *Pyrola asarifolia* Michx. infected the cones of *Picea canadensis* (Mill.) BSP.

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NOTES AND BRIEF ARTICLES

Dr. C. H. Kauffman, of the University of Michigan, is spending several days at The New York Botanical Garden continuing his studies on certain of the higher fungi preparatory to a monograph of this group.

Mr. Rafael Toro, from the Porto Rican Experiment Station, recently spent a few days at The New York Botanical Garden in connection with the study of the Pyrenomycetes of Porto Rico. Mr. Toro is spending a year at Cornell University in mycological work under the direction of Professors Whetzel and Fitzpatrick.

Professor James McMurphy of Stanford University, California, spent several days at the Garden looking over the fungous collections and methods of preserving fungi in the herbarium. Professor McMurphy is in charge of the phytopathological and mycological work in the University.

Mycologists will be glad to welcome the appearance of Dr. Roland Thaxter's third part of his "Contribution Toward a Monograph of the Laboulbeniaceae." This part deals with the group Dimorphomyceteae including the six genera *Trenomyces*, *Polyandromyces*, *Nycteromyces*, *Dimorphomyces*, *Dimeromyces*, and *Eudimeromyces* and consists of 113 pages and 12 plates. The plates are done in the same style and with the same degree of excellence as those of the preceding parts. The work is published as the "Memoirs of the American Academy of Arts and Sciences," Number V, and is a valuable contribution to science.

Brown Canker of Roses

A serious attack of the disease known as brown canker of roses was observed on August 23 among the outdoor roses at the New

York Botanical Garden, Bronx Park, New York. At that time the symptoms were particularly conspicuous on the blossoms. On the discolored petals exuded spore masses of the imperfect stage of the pathogene, *Diaporthe umbrina* Jenkins, were plainly visible with the aid of a hand lens. This trouble had been prevalent throughout the season and the gardeners had attributed it to weather conditions. The attractiveness of the rose garden was considerably lessened by the numbers of affected blossoms.

The disease has been reported as producing stem cankers at the National Rose Test Garden, Arlington Experiment Farm, Rosslyn, Virginia. It has also been observed on blossoms and other parts of the plant at a number of other places and is apparently one of the most important fungus troubles of the rose, the so-called continuous blooming varieties being particularly susceptible. The disease is known to have been present in America for a considerable period but has not generally been recognized.

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